ROCK CHIPS

ALBERTA GEOLOGICAL SURVEY

Spring/Summer 2003

Mission: Provide the geoscience information and expertise needed by government, industry and the public for earth resources stewardship and sustainable development.

Surficial Mapping in the North Lesser Slave Lake Area (NTS 83O/N)

This past summer, Quaternary geologists from the Alberta Geological Survey were busy conducting a surficial mapping program in the North Lesser Slave Lake map area as part of a multi-year initiative. The Lesser Slave region of Alberta has been subjected to numerous geological studies. However, past efforts mainly focused on the bedrock and Oligocene gravel deposits that occur in the Swan Hills, south of Lesser Slave Lake. Quaternary studies using drift prospecting and aggregate exploration methods in this region provide crucial information on the surface stratigraphy and deposit characteristics, which has direct implications for diamond exploration.

Fieldwork was conducted during July and August and provided continuity with last year's mapping program in the Peerless Lake (NTS 84B) map area to the north. Particular attention was paid to surface stratigraphy, ice flow indicators and the highly variable nature of the surface sediments. Reconnaissance-level till sampling for diamond indicator minerals and geochemistry was completed. Extensive progress was made in unravelling the glacial and postglacial history of the region.

The physiography of the region is dominated by Lesser Slave Lake. Lesser Slave Lake is one of Alberta's largest lakes – 108 km in length and covering 1160 km^2. North of Lesser Slave Lake, the Heart River Uplands is a moderate relief highland that gently slopes northeastward down to the Utikuma and Wabasca lowlands (Figure 1). East of Lesser Slave Lake, Marten Mountain rises sharply upward and marks the western extent of the Pelican Mountains. Huge volumes of ice widened and flattened the Lesser Slave Lake Valley. Lesser Slave Lake is a remnant of Glacial Lake Peace, a large glacial lake that formed at the foot of the retreating Laurentide Ice Sheet about 11 500 years ago.

Figure 1. Moraine hummocks interspersed with bogs south of Nipisi Lake in the Wabasca Plains Lowland.

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The scientific highlights from the 2002 work include the discovery of several bedrock outcrops in the Heart River Uplands and Pelican Mountains (Figure 2). Of particular interest, two coal seams were observed on the north flank of the Pelican Mountains (Figure 3). These seams likely occur in an exposure of Wapiti Formation sandstone. The upper and lower coal seams are 40 and 60 cm thick, respectively. The occurrence of these outcrops was previously unknown and warrant further investigation to refine the bedrock geology of the region.

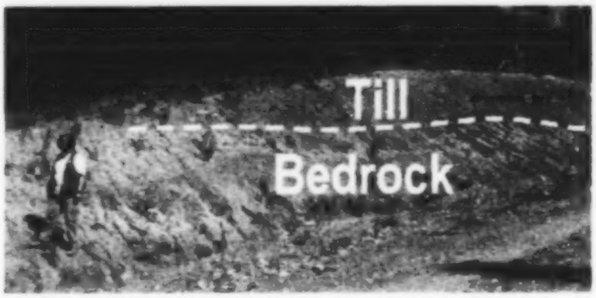

Figure 2. Bedrock exposed in a roadcut on the Pelican Mountains.

Figure 3. Bedrock exposed on the north flank of the Pelican Mountains. Note the two coal seams. A thin veneer (<2 m) of till caps the section.

On Marten Mountain and ridges to the east above 945 m (asl), quartz cobble gravel is commonly found underlying a thin veneer to glacial till (Figure 4). Powerful east-flowing rivers poured out of the Rockies and deposited the large waterworn, rounded quartzite cobbles that now cap this highland. They are similar to the deposits that cap other major uplands in Alberta, such as the Swan Hills, Caribou Mountains and Cypress Hills. These quartz cobble beds armoured the tops of the highlands, preserving them from the intense erosion that affected the surrounding stratigraphy, turning a former river bottom into a highland.

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Figure 4. A thin veneer of late Wisconsin till overlying Oligocene fluvial cobble gravels, east of Marten Mountain.

Additional evidence for multiple glacial events in north-central Alberta was found along the Willow River, south of Highway 754. At this site, a sandy non-calcareous glacial till underlies several metres of strongly oxidized sand and gravel. Calcareous till was deposited during the late Wisconsin glaciation and occurs at the top of the section (Figure 5). This site augments a rare handful of exposures and boreholes that also document an earlier glaciation (early Wisconsin?).

During the course of surficial mapping, samples of varying lithology are collected to document the nature of the Quaternary deposits. Samples were collected to provide reconnaissance information on the diamond and mineral potential of the region (Figure 6). Ideally, samples are collected from serendipitous locations where a vertical exposure provides a detailed look at the weathering profile, and subtle lateral and vertical changes in the sediment can be

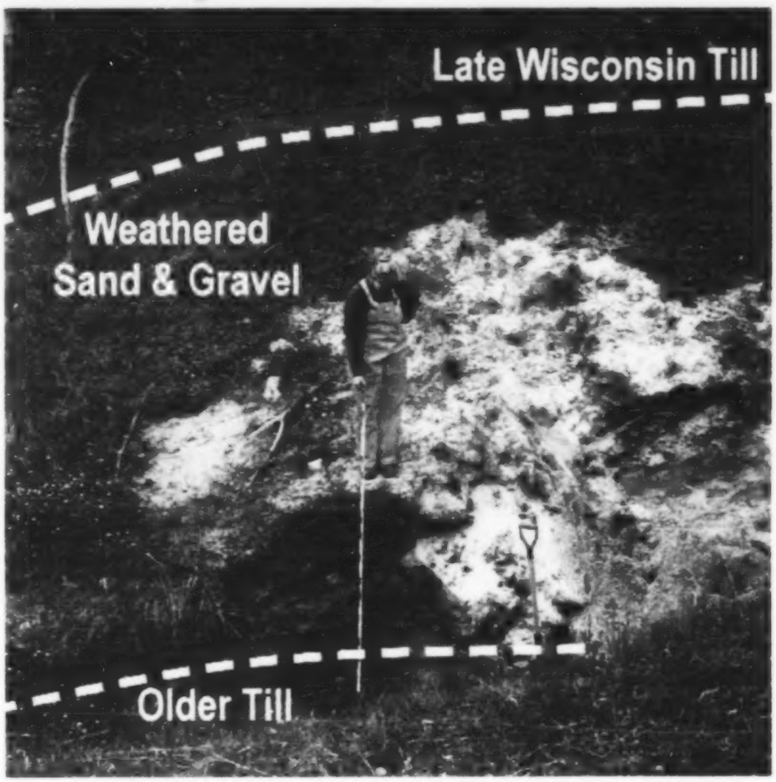


Figure 5. Older non-calcareous till is exposed in a ditch cut adjacent to the Willow River. Calcareous till, deposited during the late Wisconsin, overlies the strongly leached and oxidized sand and gravel.

documented (Figure 7). In northern Alberta, typical well drained weathering profiles of calcareous tills exhibit thick (> 10 cm) white Ae horizons (i.e., the removal of organic, clay and iron from the upper part of the soil layer). Limestone pebbles and till-matrix carbonate $CaCO_3$ are typically leached to depths of 1 m or more. The leached carbonate mobilized downward and accumulates in the lower B-Horizon where it is often noted by mottled white calcite wisps. Depth of weathering to unoxidized C-horizon till can vary considerable, but usually it is in excess of 3 m or more. The ideal sample medium is basal lodgement till, preferably unoxidized, although oxidized and leached till samples will suffice for detecting the presence of kimberlite indicator minerals. ❖

Figure 6. Sample site and mapping station in the Wabasca Plains.

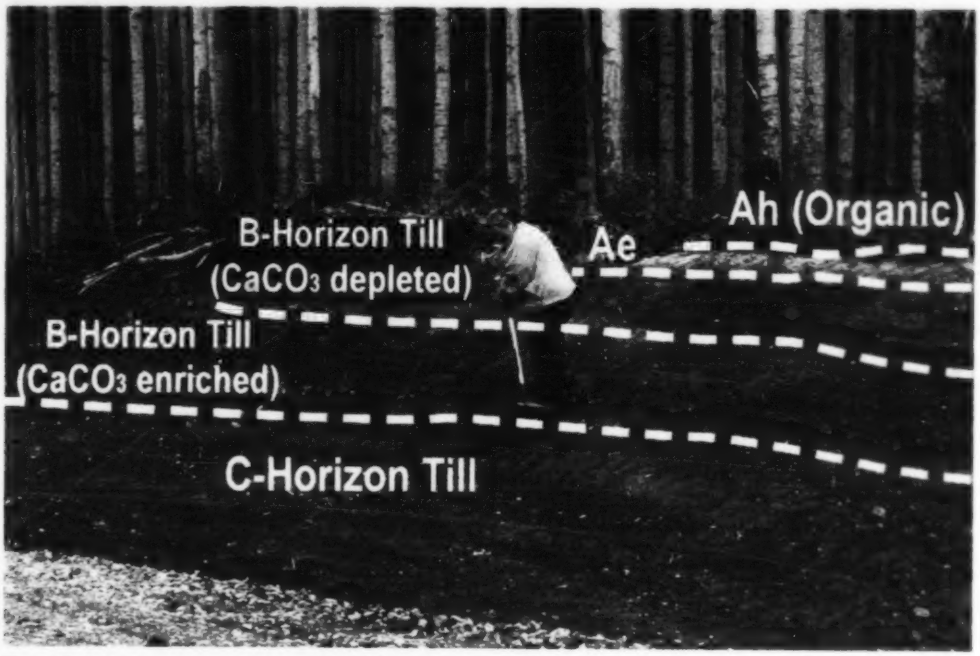


Figure 7. A fresh exposure of till provides high quality samples. Analytical results can vary greatly depending on where the till sample is collected in the weathering profile.

Geology of the Grosmont Bitumen Reservoir

The Upper Devonian Grosmont Formation is the target of a new project within the Energy section of the Alberta Geological Survey. The Grosmont Formation is an extensive bitumen-bearing carbonate complex, which extends over a region of 500 km in length and 150 km in width in northeast Alberta (Townships 60 to 108 and Ranges 1W4 to 15W5). The complex is defined to the west and south by a depositional change from platform carbonates into basinal shales and marls. Towards the east the Grosmont Formation subcrops beneath the western portions of the Cretaceous Athabasca-Wabasca oil sands deposit and is exposed at the surface in outcrops along the Peace River in the Vermilion Chutes area and along Harper Creek (see Figure 1). Its northern limit is not well known due to poor well control and the scarcity of data in the area of Wood Buffalo National Park.

The Grosmont carbonate strata dip westward from depths of less than 200 m to approximately 1000 m. The thickness of the carbonate succession varies between less than 10 m and 200 m, depending on location.

Figure 1.Outcrop along the Peace River in the Lambert/Harper Creek area.

The Grosmont carbonate complex contains an estimated 50.5 billion m^3 of crude bitumen with an average API gravity of 5° to 9°. The average bitumen saturation is 70%, locally reaching up to 100%. The Grosmont carbonates are subdivided by three shale beds into four units, the Lower Grosmont (LG/A), the Upper Grosmont 1 (UG1/B), the Upper Grosmont 2 (UG2/C) and the Upper Grosmont 3 (UG3/D). The UG2 is the major reservoir unit.

Figure 2. Vuggy dolomites of Upper Devonian Grosmont Formation at Harper Creek.

The Grosmont Formation is a regional aquifer that is heavily karstified. Karst features generally result in increased porosity and permeability but are also detrimental to seal effectiveness. The lack of understanding of the heterogeneous nature of the reservoir is the main hurdle for developing successful bitumen recovery schemes. In addition, the bitumen reserves are intensely biodegraded, with increasing biodegradation from west to east.

Future exploitation of the bitumen will likely take place along the eastern up-dip subcrop margin, where bitumen saturation and pay thickness is highest.

The new initiative of the Alberta Geological Survey's Energy section is aimed at improving the understanding of the geology and hydrogeology of the Grosmont bitumen reservoir, with special emphasis on geological factors that complicate bitumen extraction, such as karstification. This work will contribute to enhancing the future potential for bitumen recovery from the Grosmont Formation.❖

AGS Provides Information on Uppermost Cretaceous — Lower Tertiary Sequences in Wapiti Area

Industrial activities in petroleum, coal and diamond exploration continue to grow in the Wapiti-Kakwa area of Alberta (Figure 1). Information about bedrock and Quaternary geology is in constant demand for land-use planning and resource development.

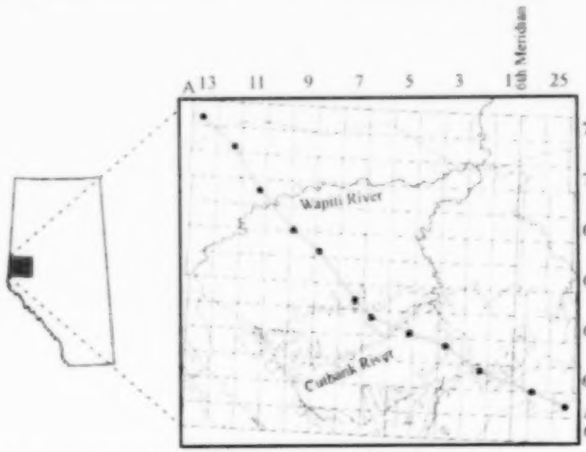


Figure 1. Locations of study area, cross-section and bedrock geology.

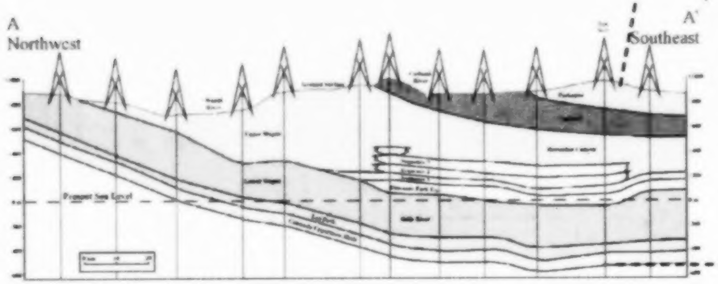


Figure 2. Cross-section showing variations of formations in the uppermost Cretaceous to lower Tertiary. Wells correspond to dots on Figure 1.

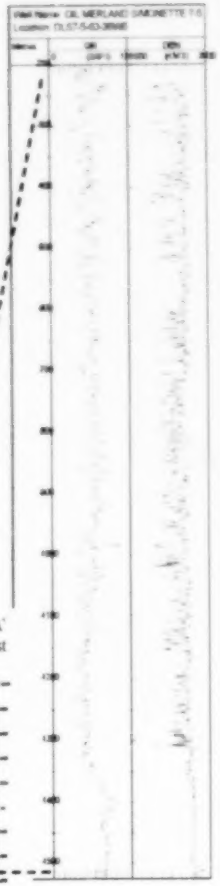


Figure 3. Type log.

Detailed stratigraphic knowledge for the uppermost Cretaceous—lower Tertiary sequences over the entire Wapiti-Kakwa area has been found to be particularly lacking. Difficulties in stratigraphic correlations in the Wapiti-Kakwa area arise from the following factors:

- The uppermost Cretaceous — lower Tertiary sequences in the Wapiti-Kakwa area straddles three domains; i.e., the west-central Alberta Plains in the southeast, northwest Alberta Plains in the north-west, and northern Alberta Foothills in the southwest.

- The stratigraphic nomenclature varies across the area (Figure 2). In the southeast, names of Belly River, Bearpaw and Horseshoe Canyon are adopted from the southern and central Plains (Figure 4). In the northwest, the name of Wapiti is applied. In the southwest, the name of Brazeau is used.

- The uppermost Cretaceous — lower Tertiary formations are well preserved in the southern area only (Figure 3). The formations dip south and are increasingly eroded toward the north (Figure 2). In the southwest, the strata are forded and stripped parallel to the Rocky Mountain deformation front (Figure 1).

- Changes in lithology, facies and thickness in the area appear to be significant from shelf and shoreline setting to the fluvial regime. The change is drastic in Bearpaw equivalent sequences, and the Dinosaur Park equivalent sequences are present where shoreline transgressions and regressions developed. The sequences disappear landward on the basin margin (Figure 2).

AGS continues to develop an integrated basin-scale approach to resolving complete stratigraphic issues in support of regulatory activities for the provincial government and the resource sector. ❖

Figure 4. Outcrop of the Belly River to Horseshoe Canyon formations on the North Saskatchewan River near Edmonton.

Collaborative Quaternary Mapping Project for Northwestern Alberta

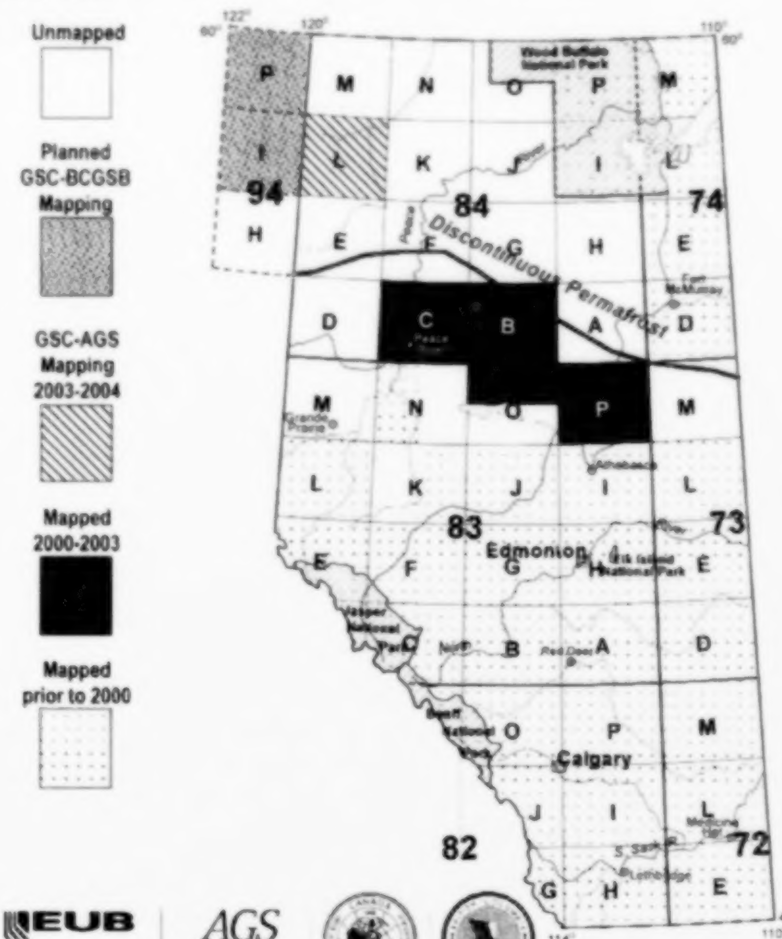
This year, the Alberta Geological Survey (AGS) marks the fourth year in its long-term, regional surficial mapping initiative for northern Alberta. Mineral exploration for kimberlite, uranium and shallow gas energy targets remain active in northern Alberta. Thus, the Alberta Geological Survey continues to support the exploration community by providing baseline geological information.

Over the next four years, the Alberta Geological Survey will participate in a collaborative, multidisciplinary project with the Geological Survey of Canada (GSC). GSC staff, led by Beth McClenaghan, will participate in surficial mapping, drift stratigraphy and thickness studies in northwestern Alberta. Other related research to this project will include geochemistry surveys, kimberlite studies and glacial dispersion studies in thick overburden. Adjacent to the surficial mapping in northwest Alberta, the British Columbia Geological Survey is also a participant in the project. This large project is part of a new northern development initiative by the Earth Sciences Sector, Natural Resources Canada. A large part of this multi-partnered project is to map the surficial geology in northeastern British Columbia and northwestern Alberta with continuous, seamless map coverage.

The AGS-GSC goal for this upcoming field season will be to map the Zama Lake (NTS 84L) map area (see figure). This area is renowned for one of the last big conventional bedrock energy plays in northern Alberta. However, recent interest in natural gas trapped in unconventional, Quaternary glaciofluvial reservoirs provides additional impetus to map the surficial geology, stratigraphy and drift thickness/bedrock topography in the region.

As well, maps containing surficial geology information, Quaternary stratigraphy and glacial history are essential to mineral exploration in northern Alberta. The surficial geology map also provides important information on the various types of surficial materials, ice-flow transport directions and delineates regions containing ideal sampling media (e.g., till, soil or stream sediments) for drift prospecting surveys. Through this work, AGS will provide basic geological information for mineral exploration and resource development in northern Alberta.

For additional information about this project, see the Fall/Winter 2003 Rock Chips for preliminary scientific discoveries and highlights from the Zama Lake collaborative surficial mapping program. ❖



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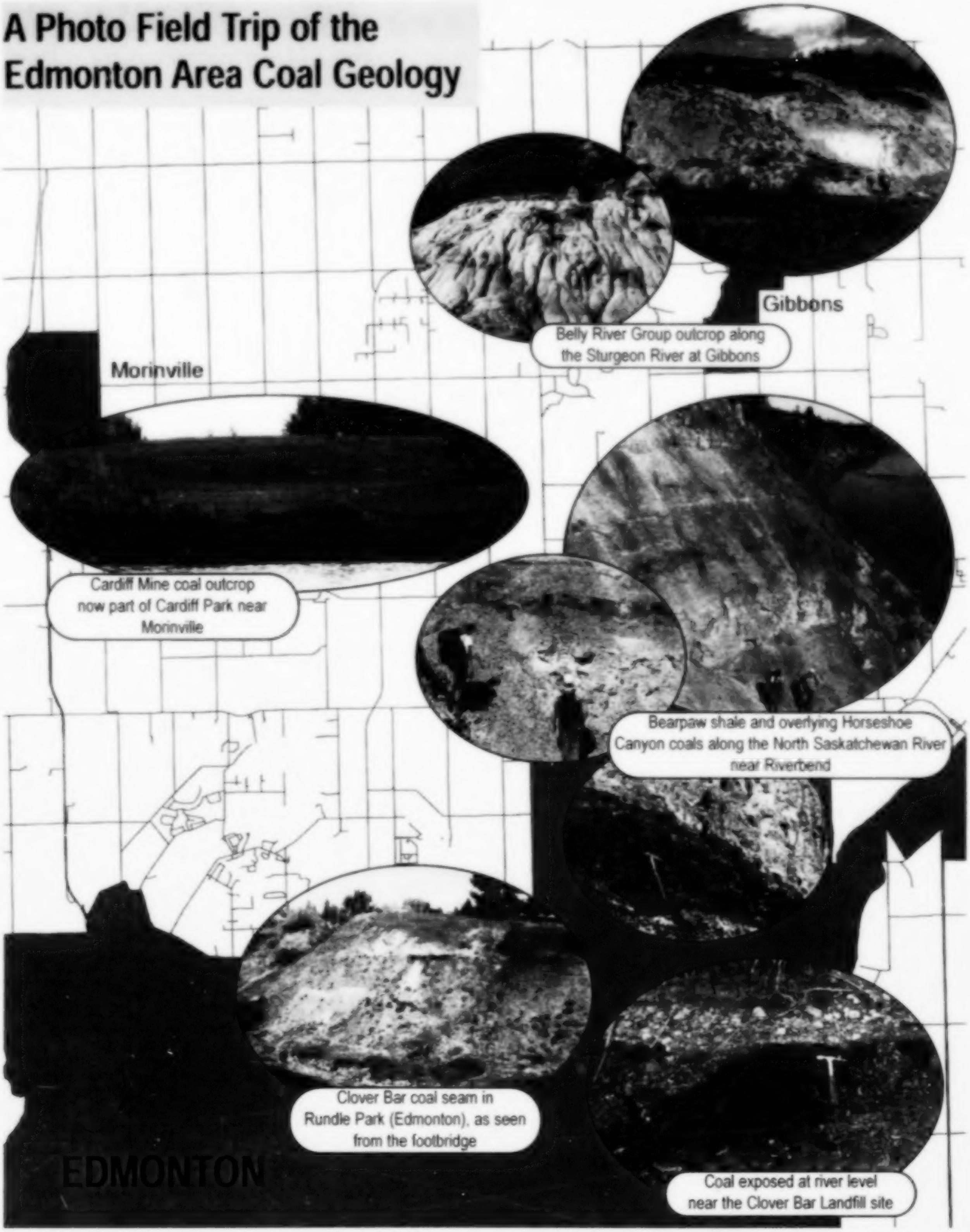
A Photo Field Trip of the Edmonton Area Coal Geology



Belly River Group outcrop along the Sturgeon River at Gibbons

Cardiff Mine coal outcrop now part of Cardiff Park near Morinville

Bearpaw shale and overlying Horseshoe Canyon coals along the North Saskatchewan River near Riverbend

Clover Bar coal seam in Rundle Park (Edmonton), as seen from the footbridge

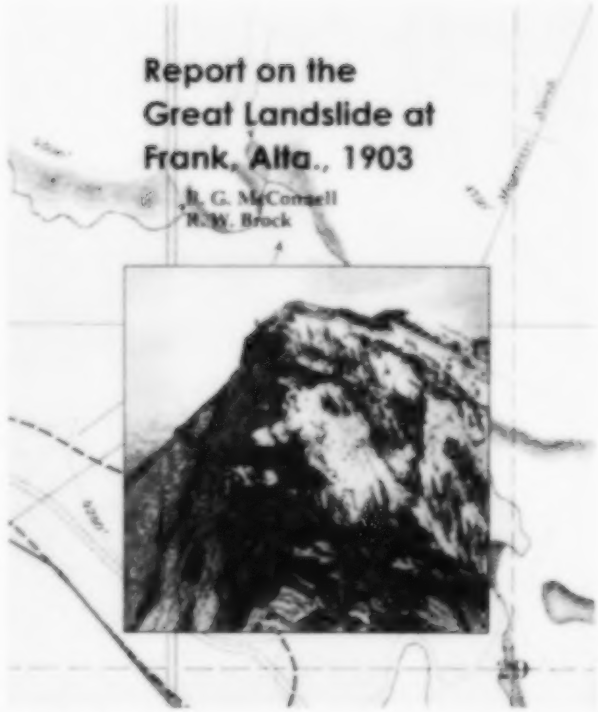
Coal exposed at river level near the Clover Bar Landfill site

Book Released on the Frank, Landslide of 1903

In 1933, John Allen of AGS reported to the Alberta government about the possibility of another Frank Slide from the South Peak of Turtle Mountain. A copy of the report is in the Provincial Archives. In 1999, AGS provided advice to Alberta Environment, as part of a project, assessing the stability of South Peak. The conclusions and recommendations can be obtained from Willem Langenberg at the Alberta Geological Survey.

On April 30, 1903, a day after the Frank Slide, R.G. McConnell and R.W. Brock of the Geological Survey of Canada were instructed to investigate the catastrophe. Their report was published in 1904 and has long been out of print. The Edmonton Geological Society decided to reprint this report, including the original map and cross-section, on the occasion of the centennial of the Frank Slide in 2003. This careful contemporary account of the landslide's impact on the town of Frank is still one of the very few available for risk assessment studies. The book is a must for anybody interested in landslides. The suggested retail price is $9.95.

This book can be ordered directly from the Edmonton Geological Society (see address on right). For people residing outside Canada the price is $9.95US, which includes shipping. Only cash, postal money orders and banks' international money orders will be accepted for foreign orders.❖



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Collaborative Quaternary Mapping Project for Northwestern Alberta	Roger Paulen	(780) 427-2851
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Book Released on the Frank Landslide of 1903	Willem Langenberg	(780) 427-0809
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Evaluating the Coalbed Methane Potential of a Coal Seam	Andrew Beaton	(780) 427-3272

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Evaluating the Coalbed Methane Potential of a Coal Seam

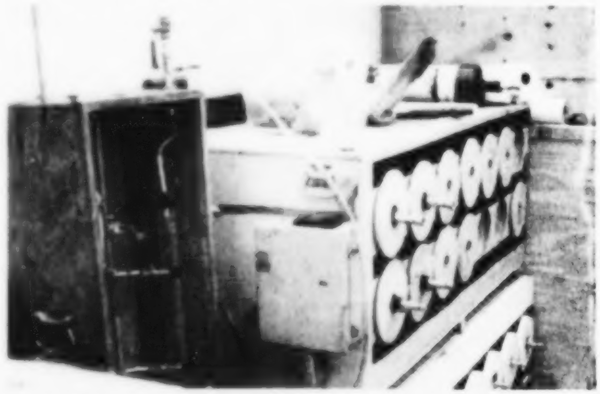
Coal is derived from organic matter (peat) that has undergone burial and compaction. As the peat progressively changes (matures) into coal, associated physical and chemical changes in the organic matter result in the generation and liberation of volatile matter, including methane. Methane retained within the seam is held in place by pressure from the weight of the overlying rock mass. This methane may be produced from a well, provided the pressure can be lowered, thereby releasing the methane from the coal matrix. Pressure may be reduced by pumping water from the seam. Gas can then flow into the wellbore if sufficient flow pathways (permeability) exist. The presence of closely-spaced, pervasive fractures (cleats) within the coal seam is required to allow gas movement through the seam and out of the well bore.

CBM exploration involves identifying coal seams with potential for open fractures or cleats, and identifying areas with adequate gas concentrations. Prospective coal seams are drilled and sampled to test gas content and coal reservoir properties. CBM exploration wells collect cores or chips of the coal seam. Cores are preferred, as the nature of coal cleating, potential mineralization of the cleat, and true representative chemistry and physical composition of the coal seam is obtained.

Geologist describing coal core.

When a coal core is cut, it is quickly brought to surface and removed from the core barrel. The core is quickly described and divided into intervals that represent the general characteristics of the seam. These core intervals are placed in desorption canisters, sealed and maintained at reservoir temperature.

The coal will have been releasing (or desorbing) gas from the time it left the seam in the ground. Within the canisters, gas is continually desorbing from the coal. The amount of gas released is measured by attaching the canister to a burette. Gas exiting the canister displaces fluid levels in the burette, allowing for measurement of desorbed gas. Cumulative gas desorbed from the canister over time is recorded on a gas desorption plot. The data is extrapolated to time "zero," which incorporates desorbed gas "lost" during the core retrieval process. When gas ceases to desorb from the core at reservoir temperature, temperature may be increased to evolve the last bit of "residual" gas. Total lost gas, measured gas and residual gas are corrected for standard temperature and pressure conditions, resulting in a measure of total gas within the sample.



Bank of desorption canisters containing coal samples (right) and the burette setup for measuring desorbed gas (on the wall).

Desorption rates, determined by keeping the sample at reservoir temperatures, assist in evaluating the reservoir production characteristics of the seam. Seam reservoir permeability is indicated by the extent of cleating and fracturing of the coal, and may be quantified by conventional well flow-buildup testing, or by conducting injection-falloff tests. ❖

Recently Released AGS Publications (cont. on next page)

ESR 2002-02 Precambrian Basement of the Western Canada Sedimentary Basin in Northern Alberta. 1.49 MB PDF. 2003. $20.00

ESR 2002-03 Quaternary Geological Setting of the Athabasca Oil Sands (In Situ) Area, Northeast Alberta. 130 MB PDF. 2003. $20.00

GEO 2002-06 Baseline Discharge and Geochemistry of the Wiau Channel Springs, 1999-2001, Athabasca Oil Sands (In Situ) Area, Alberta. 6.70 MB PDF. 2003. $20.00

The following four maps are sold together on one CD for $25.00.

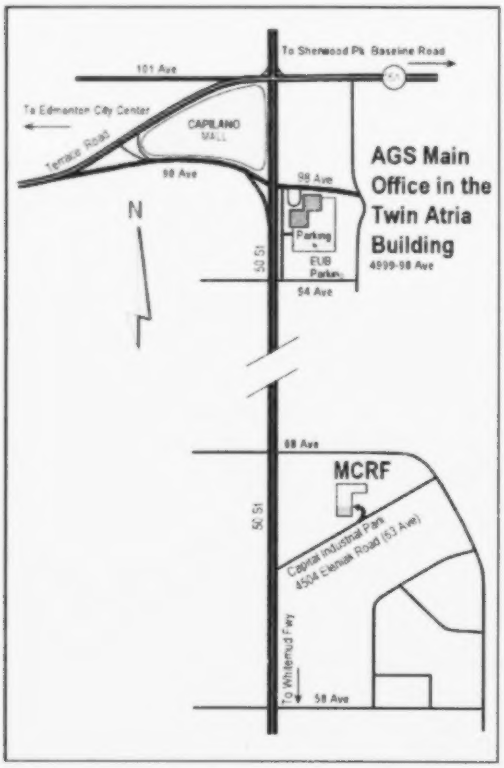
Map 265 Surficial Geology of the Southeast Buffalo Head Hills Area, (NTS 84B/NW). Scale 1:100 000. 3.81 MB PDF. 2003

Map 266 Surficial Geology of the Lubicon Lake Area, (NTS 84B/SW. Scale 1:100 000. 4.13 MB PDF. 2003

Map 267 Surficial Geology of the Peerless Highlands Area, (NTS 84B/NE). Scale 1:100 000. 7.78 MB PDF. 2003

Map 268 Surficial Geology of the Trout River Area, (NTS 84B/SE). Scale 1:100 000. 5.69 MB PDF. 2003

The following groundwater reports are sold on behalf of the Prairie Farm Rehabilitation Administration (PFRA). Please contact them for further information.



SPE 57 Lakeland County, Regional Groundwater Assessment —Final. 399 MB. 2003. $20.00

SPE 58 M.D. of Bonnyville Regional Groundwater Assessment —Final . 620 MB. 2003. $20.00

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